

# Hurricane Imaging Radiometer (HIRAD)

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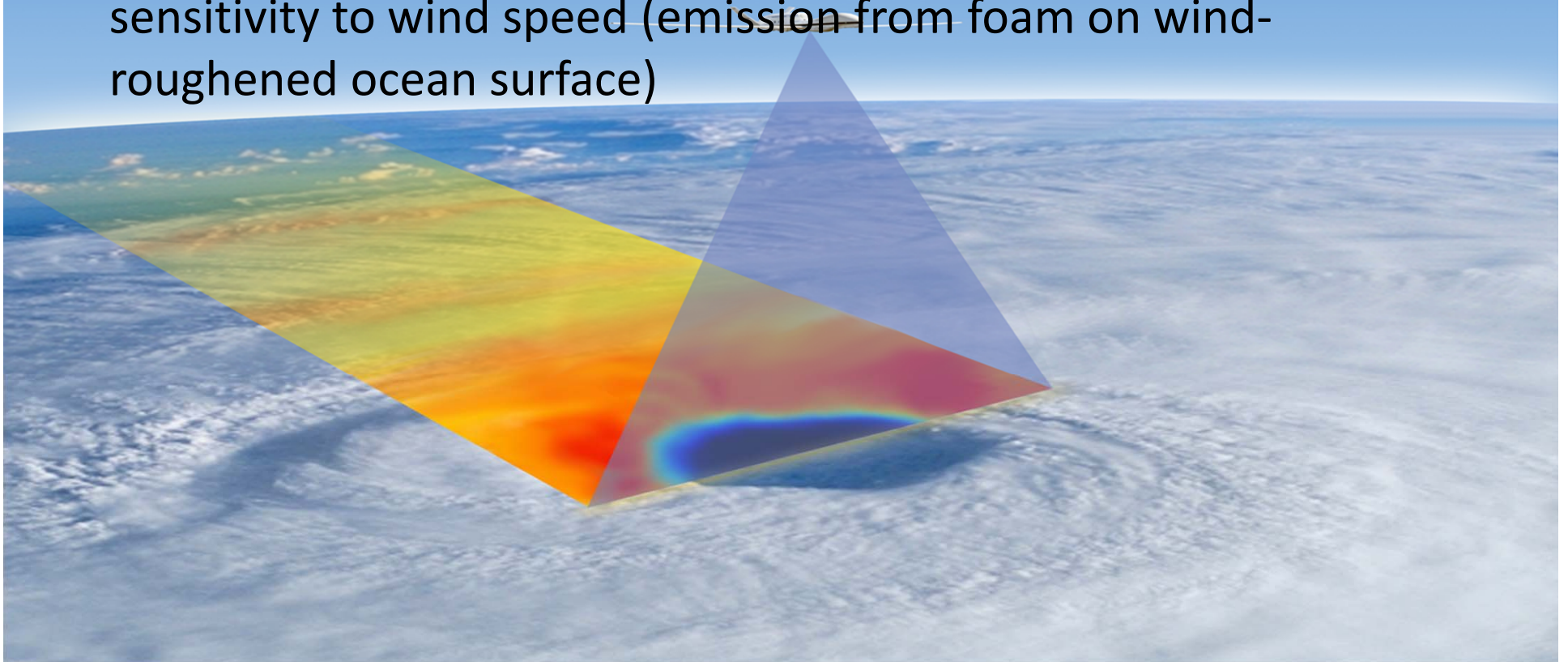


# HIRAD Background

C-band (4, 5, 6, 6.6 GHz) radiometer with retrieval concept similar to SFMR

## **Retrieve Wind Speed and Rain Rate over ocean**

C-band frequencies have varying sensitivity to rain but equal sensitivity to wind speed (emission from foam on wind-roughened ocean surface)





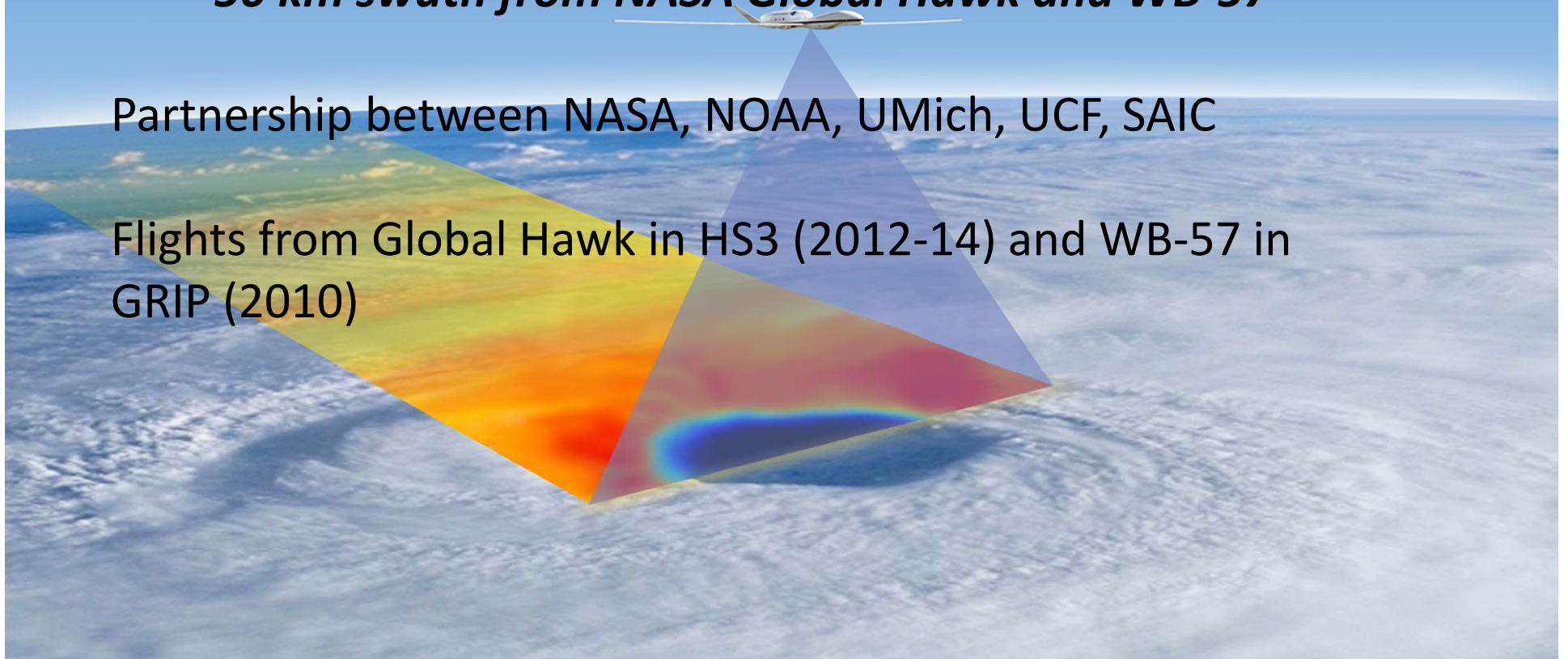
# HIRAD Background

Combination of frequencies (4, 5, 6, 6.6 GHz) allows simultaneous retrieval of wind and rain

STAR antenna technology allows observation of wide swath below aircraft – ***swath width about 2.5 x aircraft altitude***  
***~50 km swath from NASA Global Hawk and WB-57***

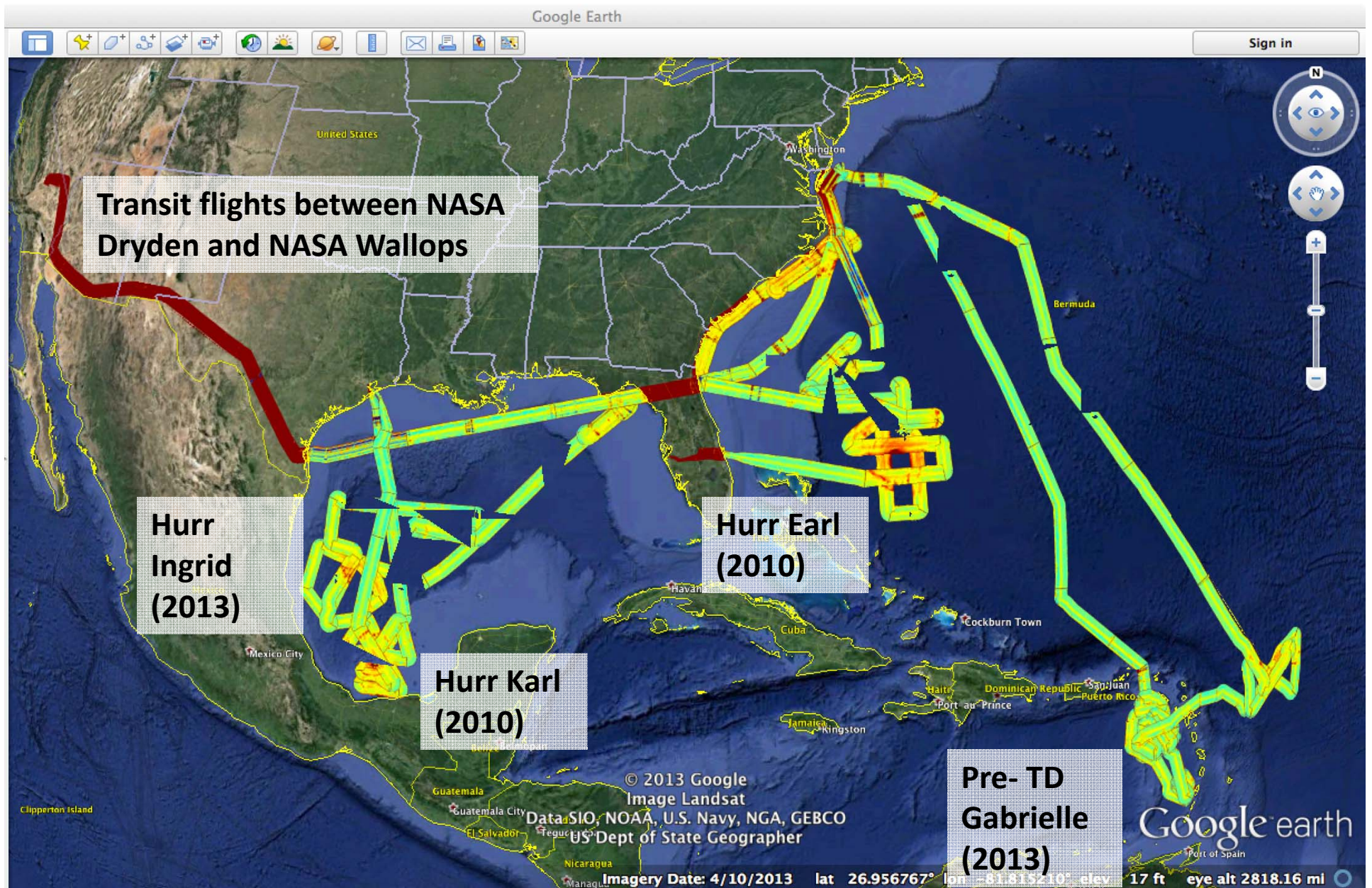
Partnership between NASA, NOAA, UMich, UCF, SAIC

Flights from Global Hawk in HS3 (2012-14) and WB-57 in GRIP (2010)



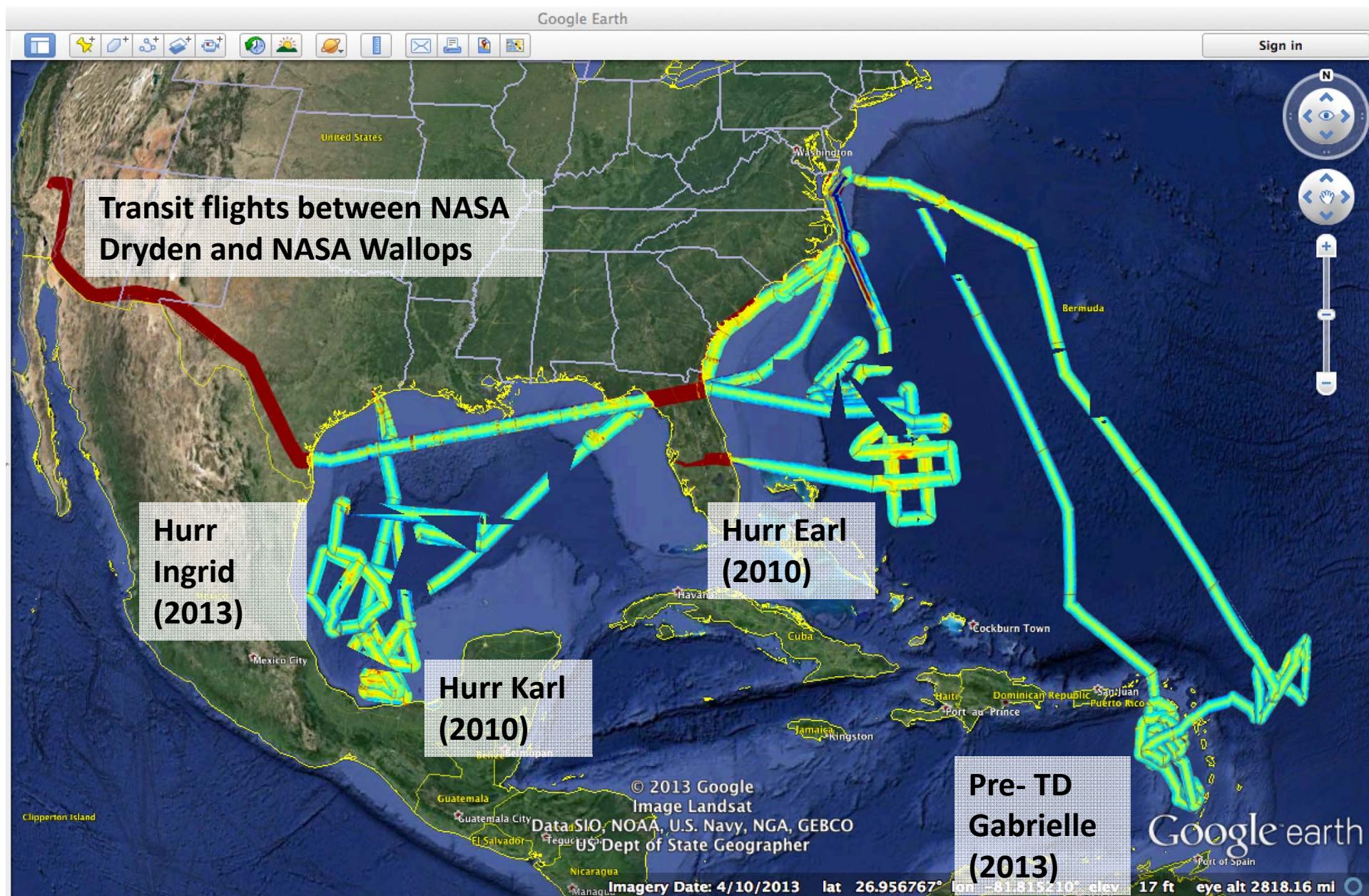


# Flights in 2010 & 2013 - 6.6 GHz TB



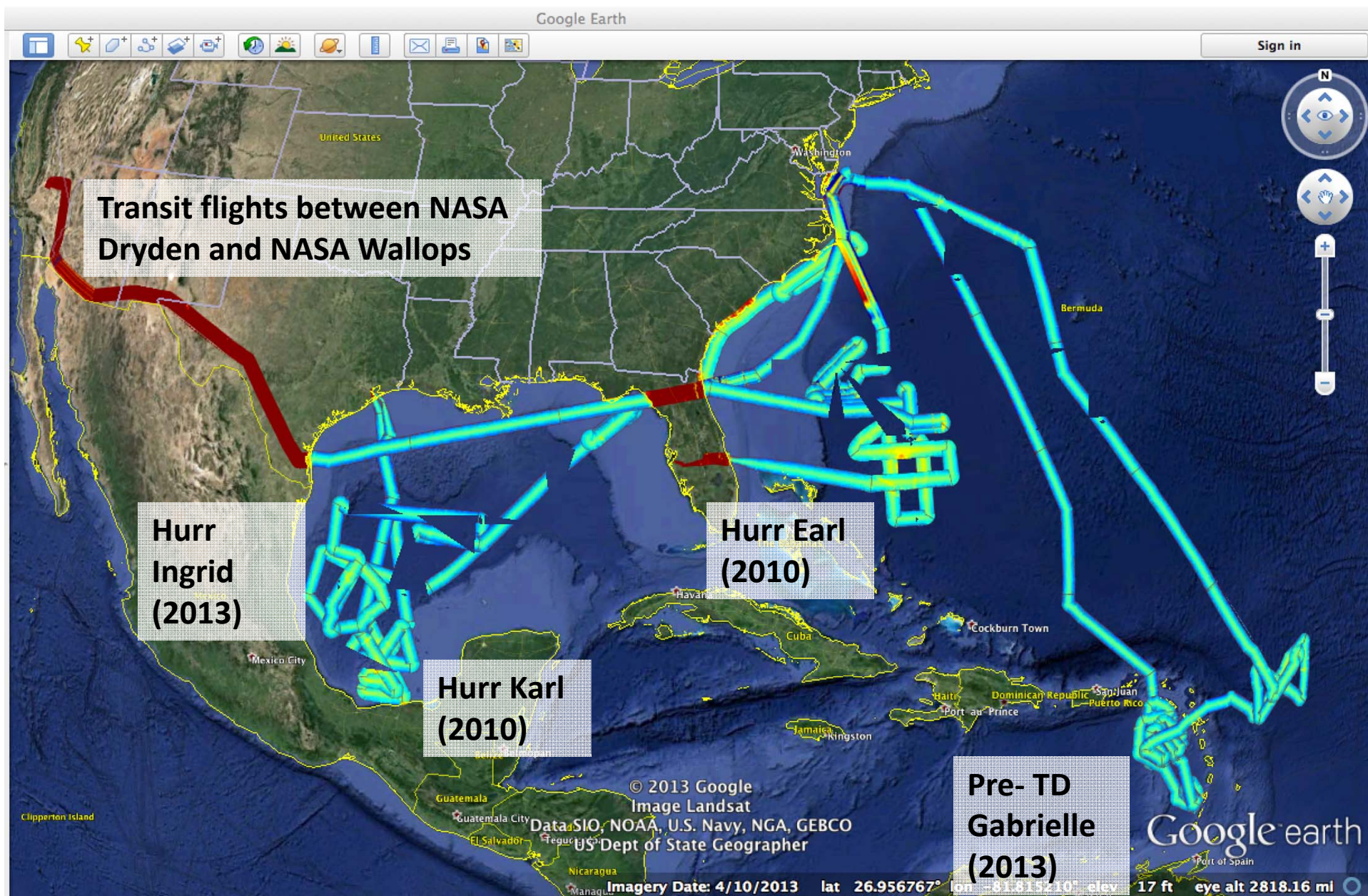


# Flights in 2010 & 2013 - 6.0 GHz TB





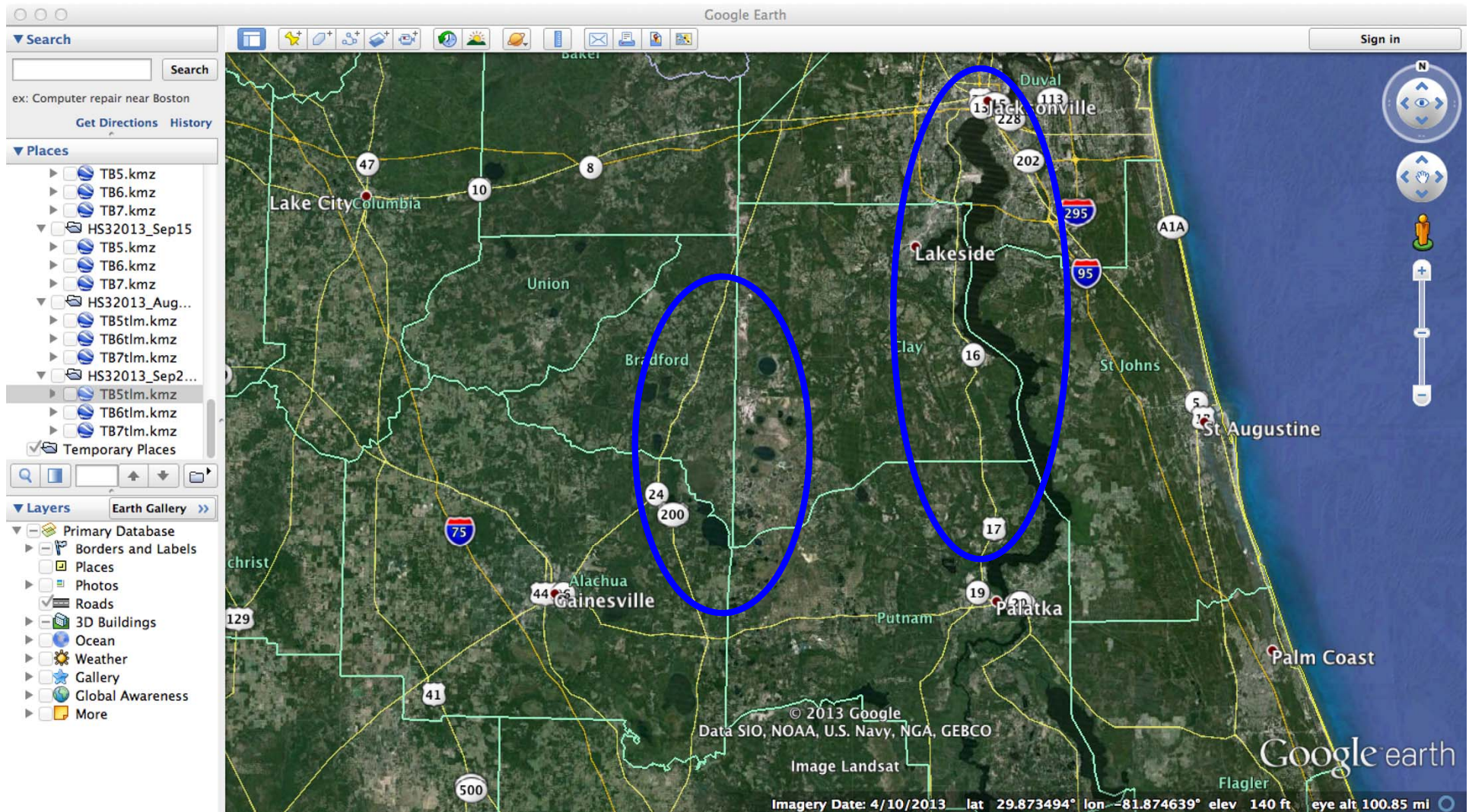
# Flights in 2010 & 2013 - 5.0 GHz TB





# Cross-Scan structure

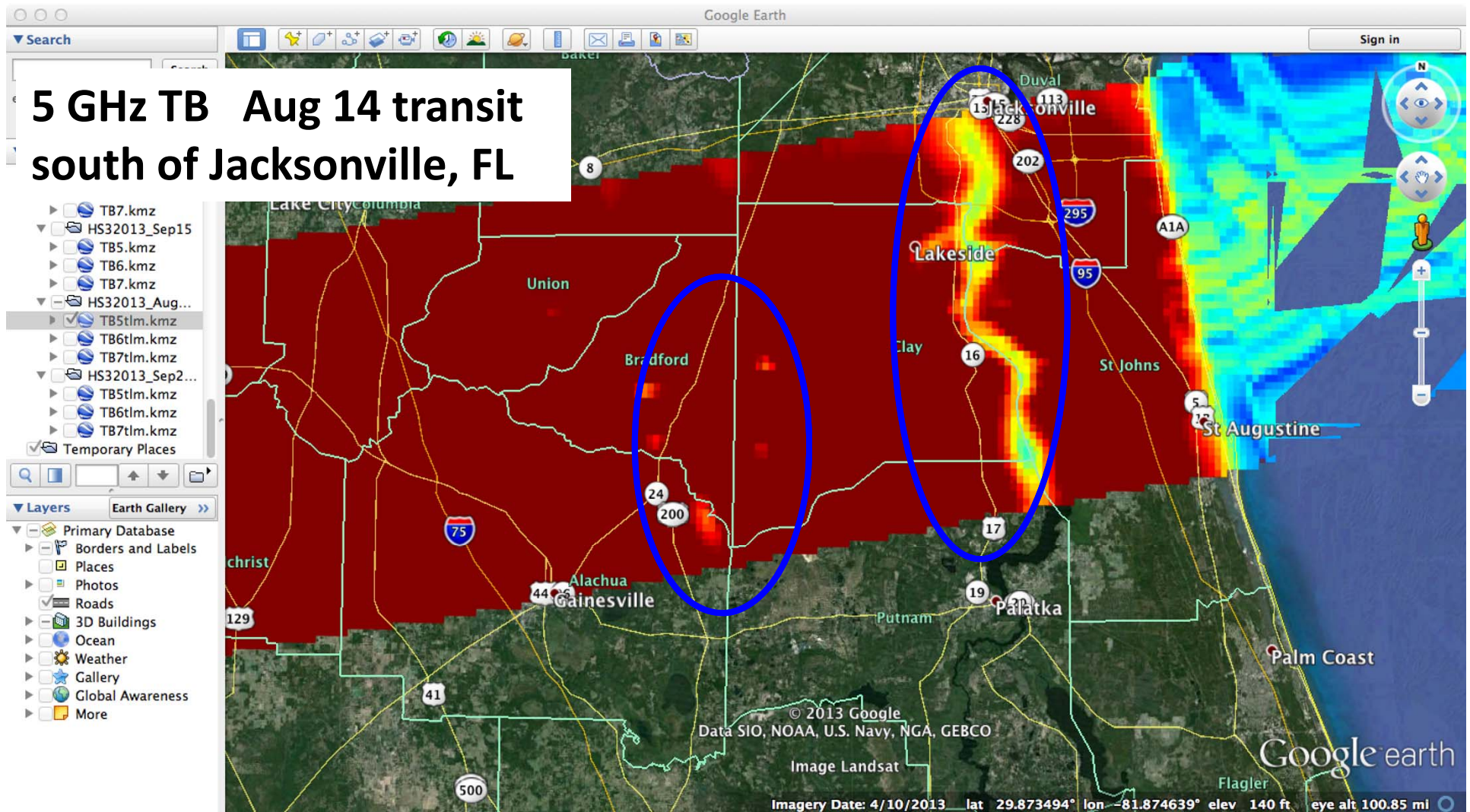
- Synthetic Thinned Array Radiometer (STAR) antenna technology
- The antenna is not mechanically scanning across discrete scenes
- Instead the swath is derived based on combination of signals from many antenna patches
- Want to confirm that real spatial structures are represented in the swath





# Cross-Scan structure

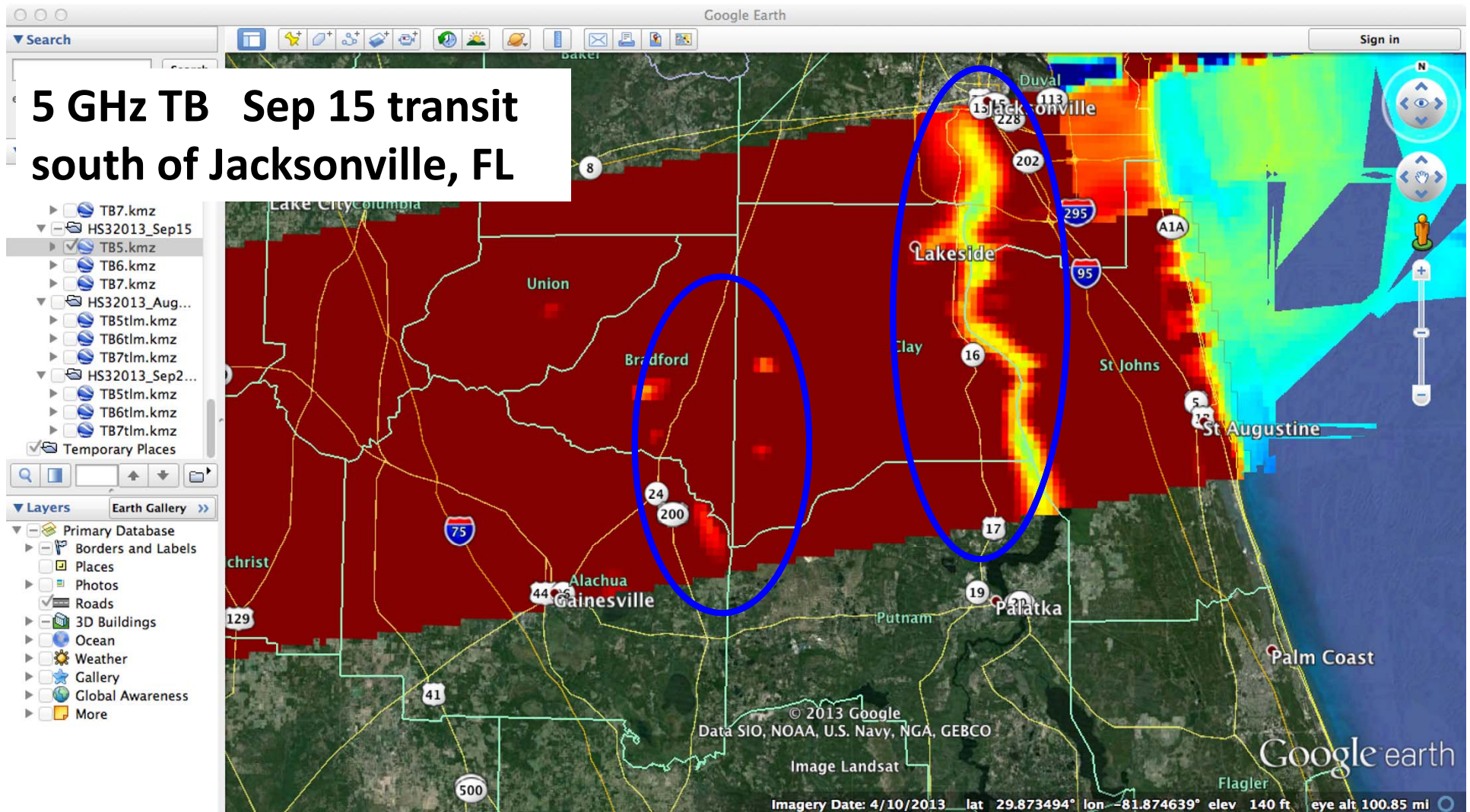
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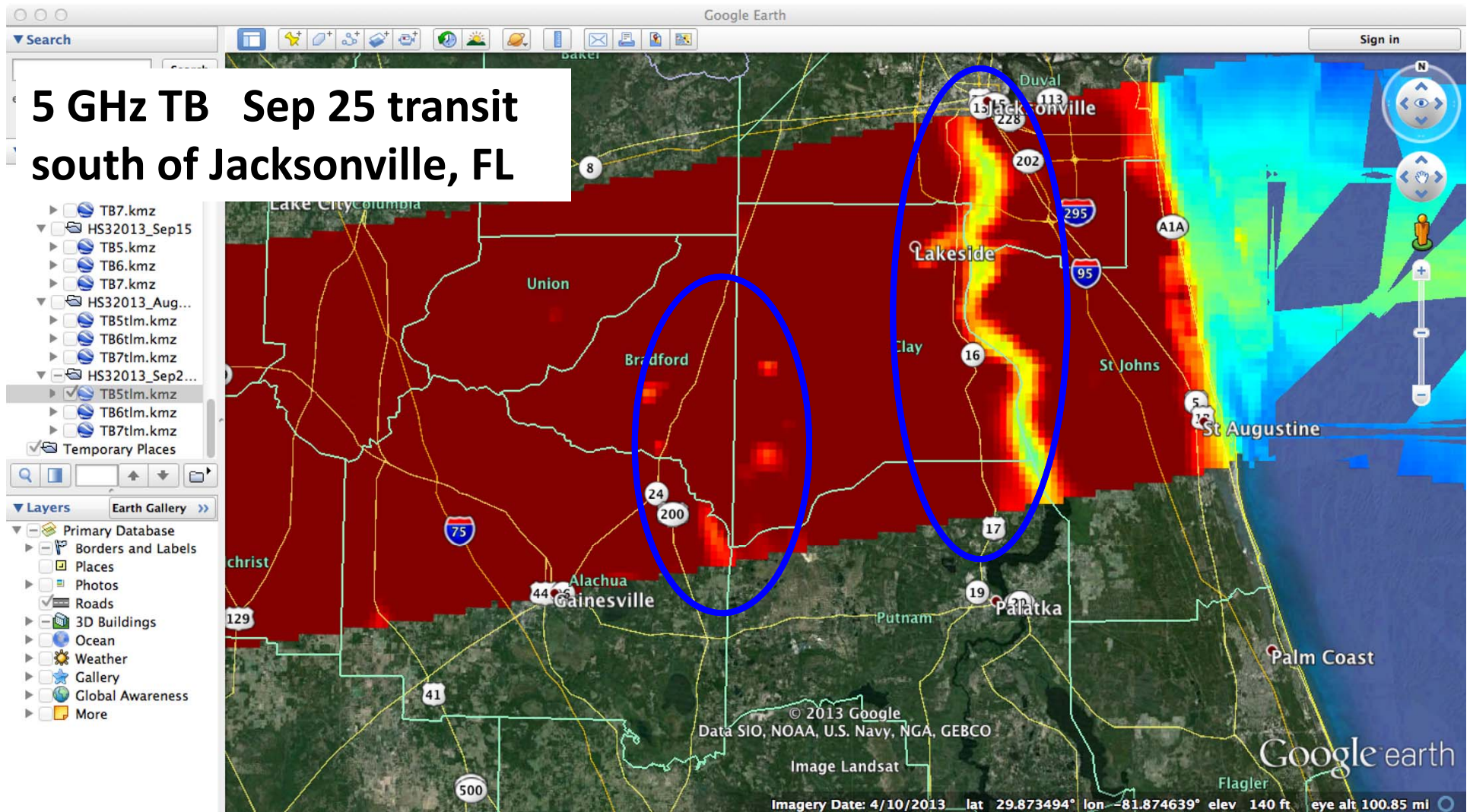
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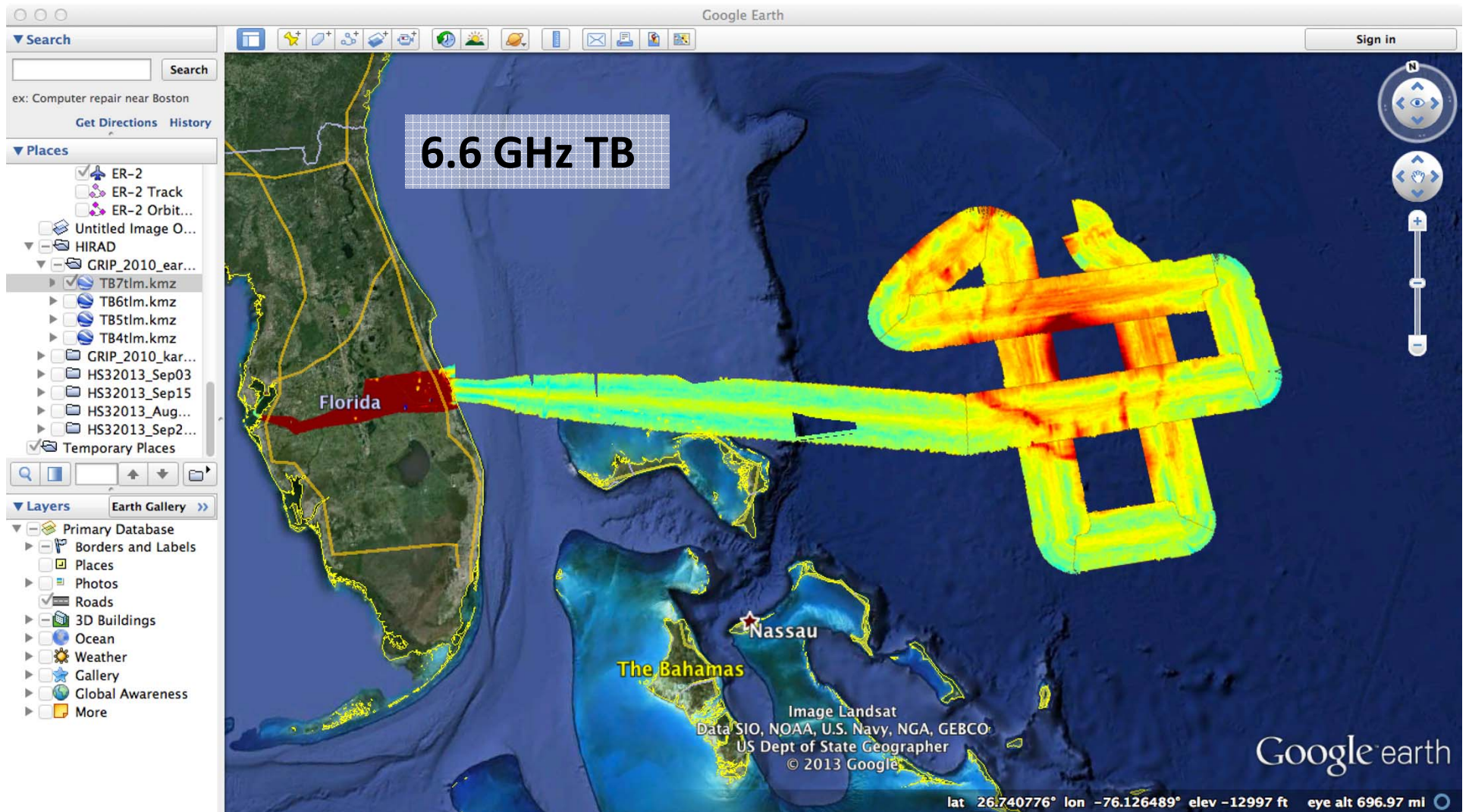
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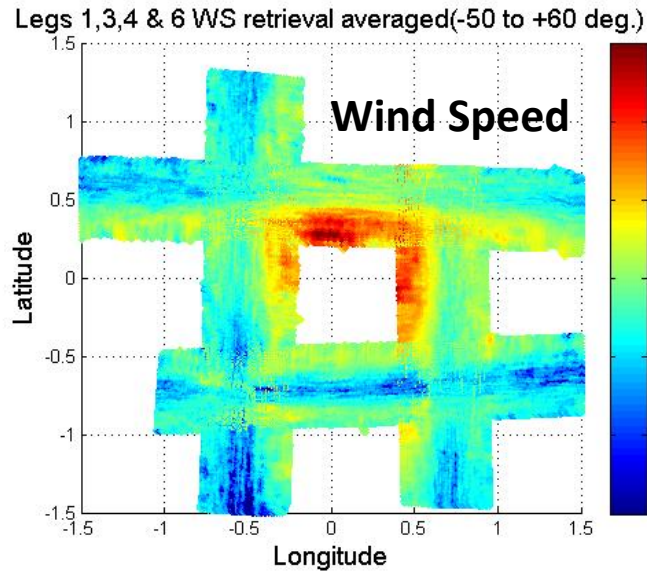


# Hurricane Earl (2010) Brightness Temp





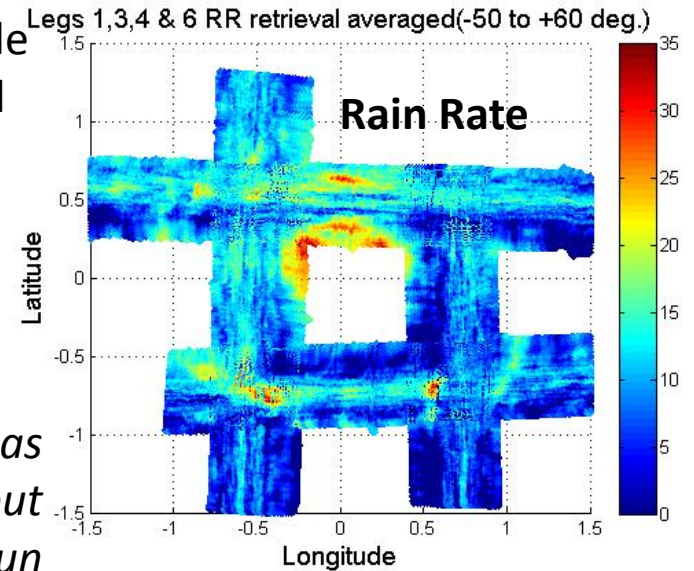
# Hurricane Earl (2010) retrievals



Aircraft track was outside the eyewall, but eyewall was mostly mapped within the swath

There are across-track biases to clean up

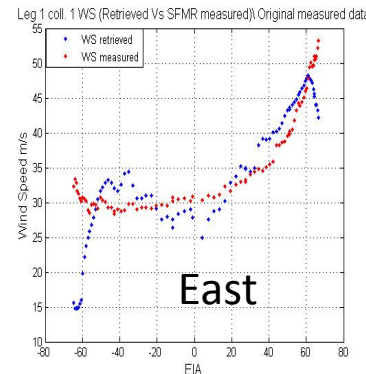
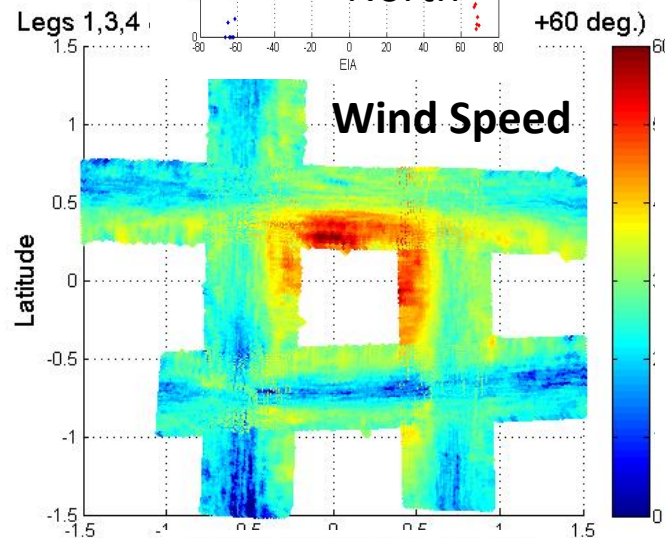
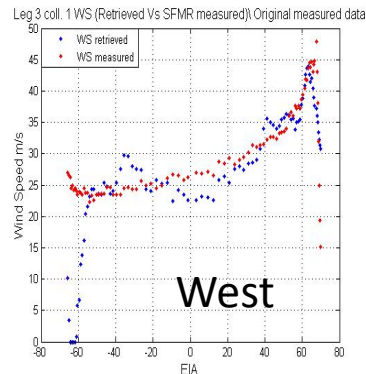
*New antenna pattern has improved this, but retrievals not yet re-run for this case*





# Hurricane Earl (2010) retrievals

*X-axis Earth Incidence Angle (EIA) corresponds to about 300 m per degree of EIA*

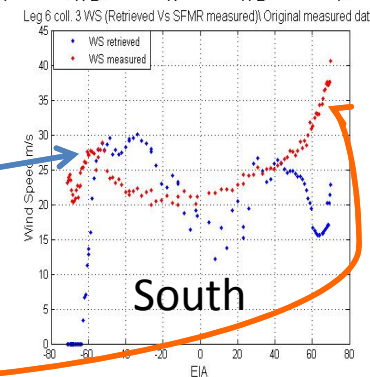


HIRAD retrievals (blue) mostly match up well with SFMR retrievals (red) in places where SFMR flew through the HIRAD swath.

HIRAD data appears good between  $-50^\circ$  -  $+60^\circ$  azimuths.

Some differences due to tens of minutes offset between observations.

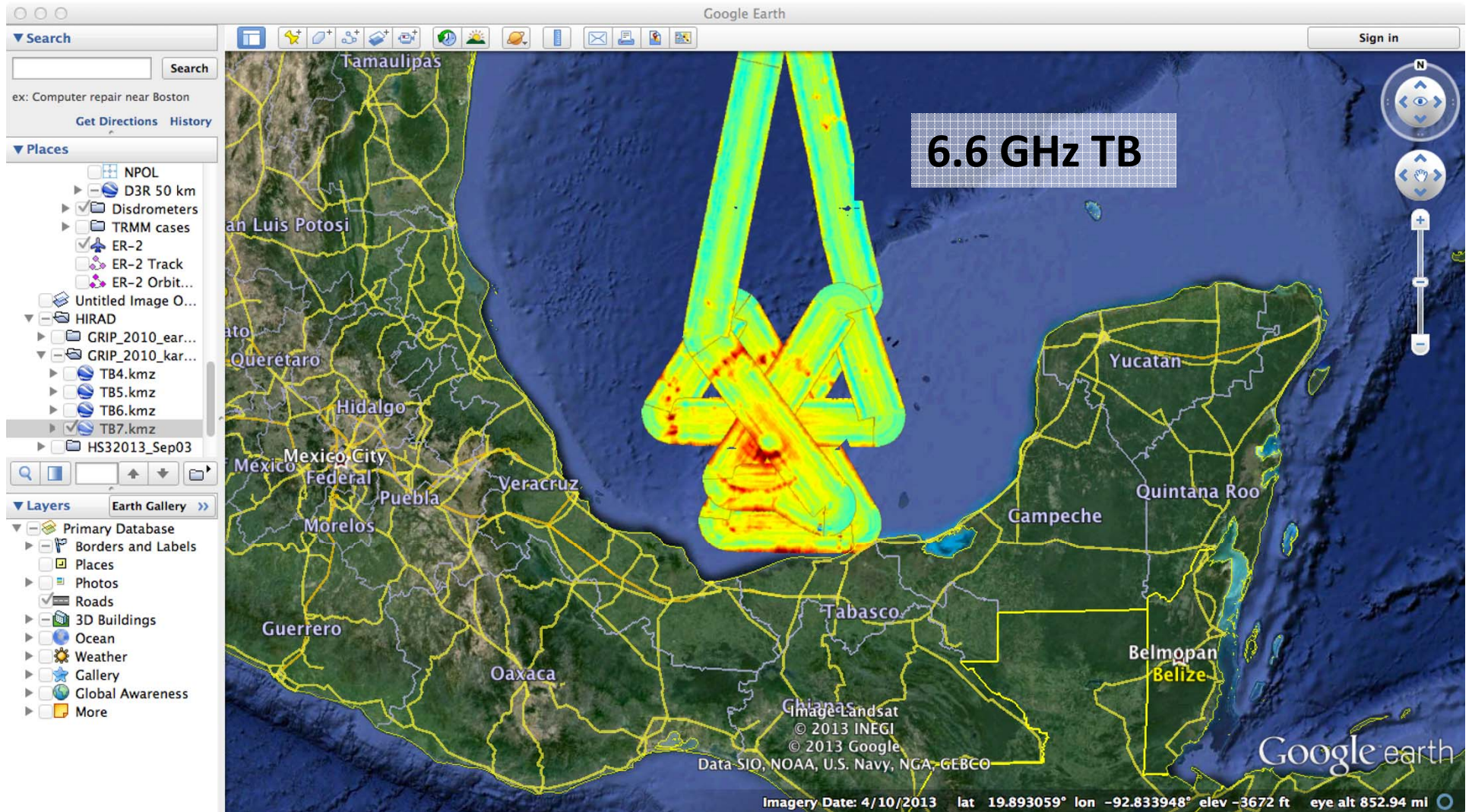
*Large differences on south side: HIRAD sees secondary eyewall further north than SFMR, does not see peak eyewall winds*



Cross-track bias should be improved when retrievals are re-run using latest antenna pattern

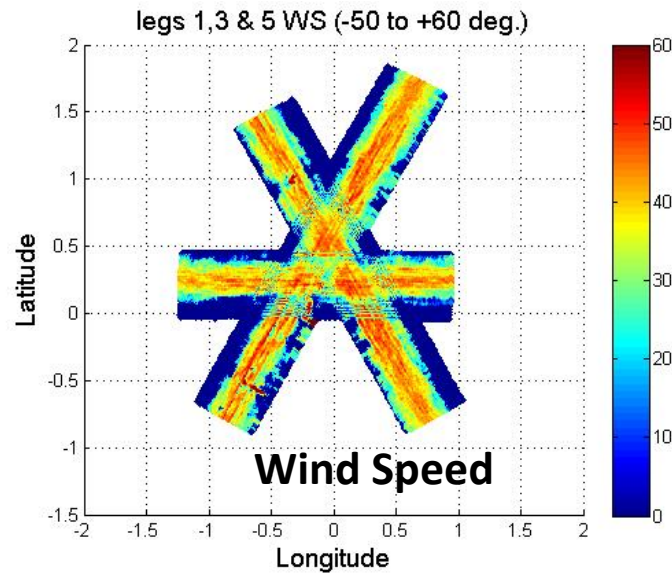


# Hurricane Karl (2010) Brightness Temp

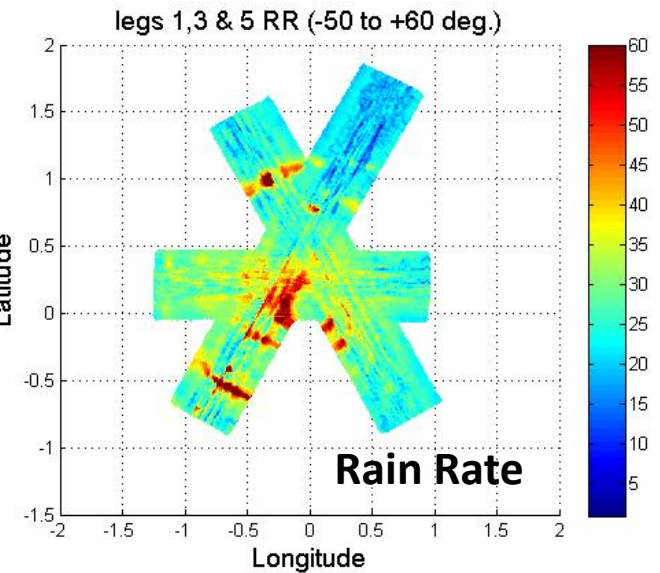




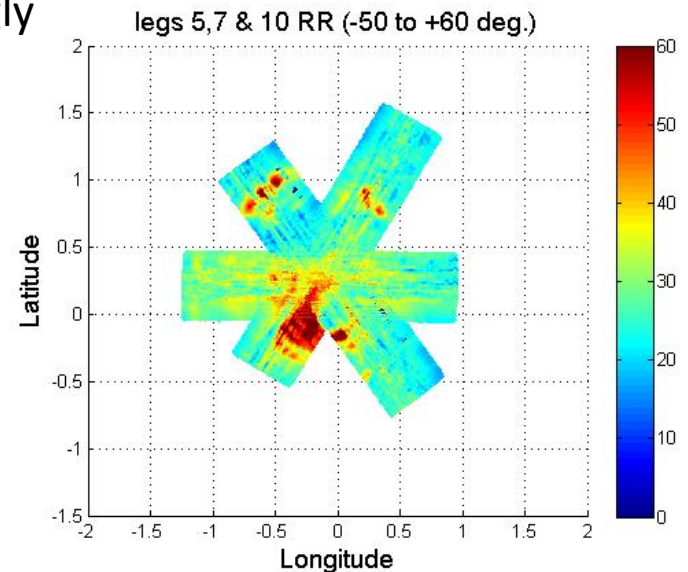
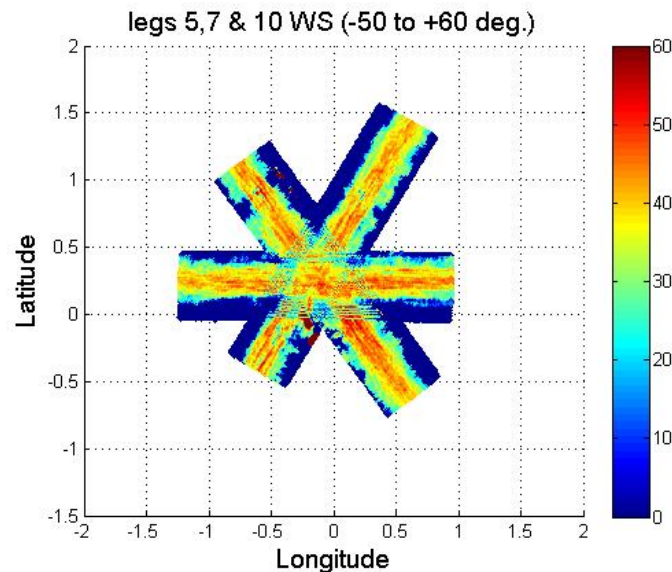
# Hurricane Karl (2010) retrievals



We do not yet know why, but the Hurricane Karl wind speed retrievals (left) are disappointing. This set of retrievals is new, and needs much more investigation

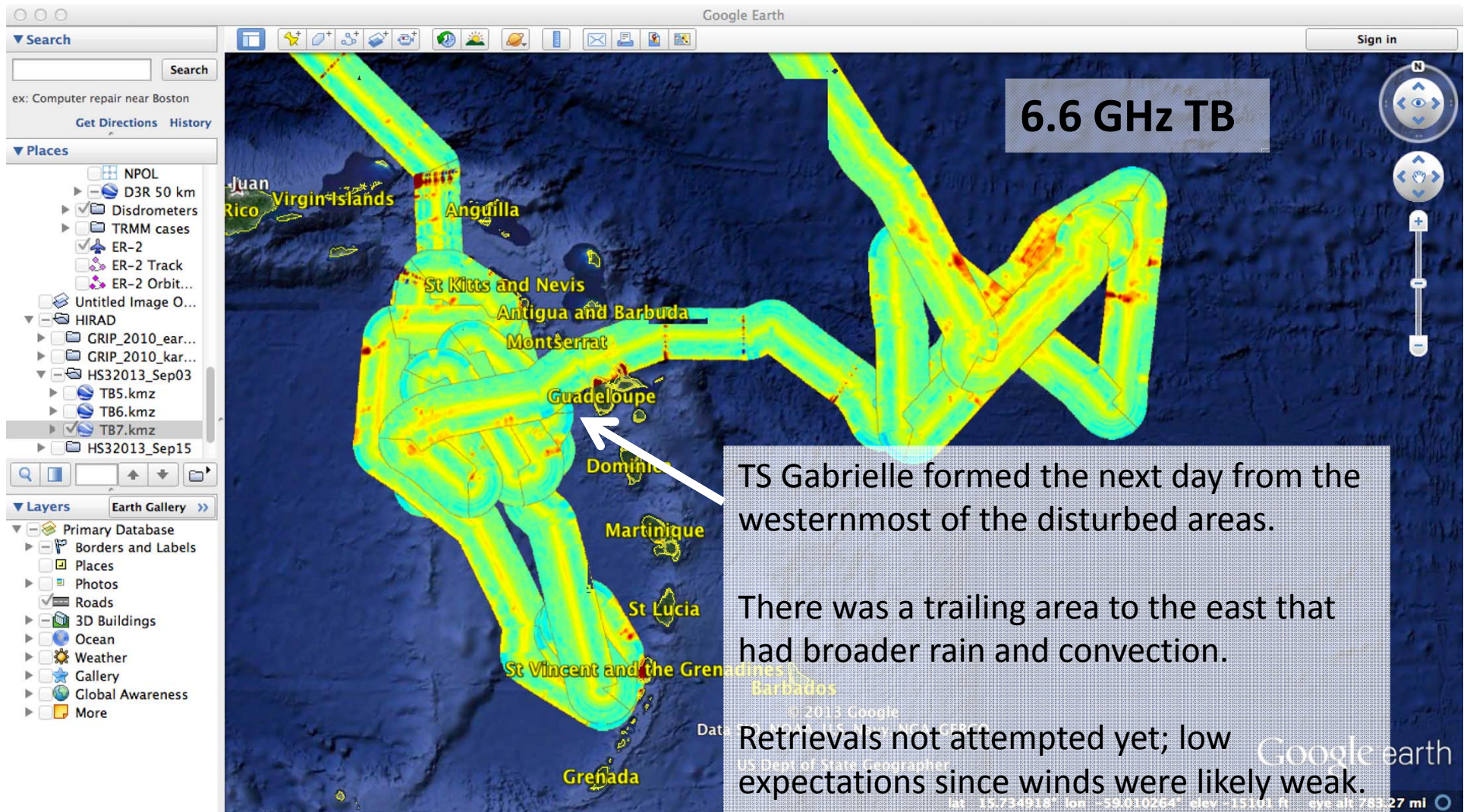


The rain retrievals (right) show surprisingly good structure in comparison.



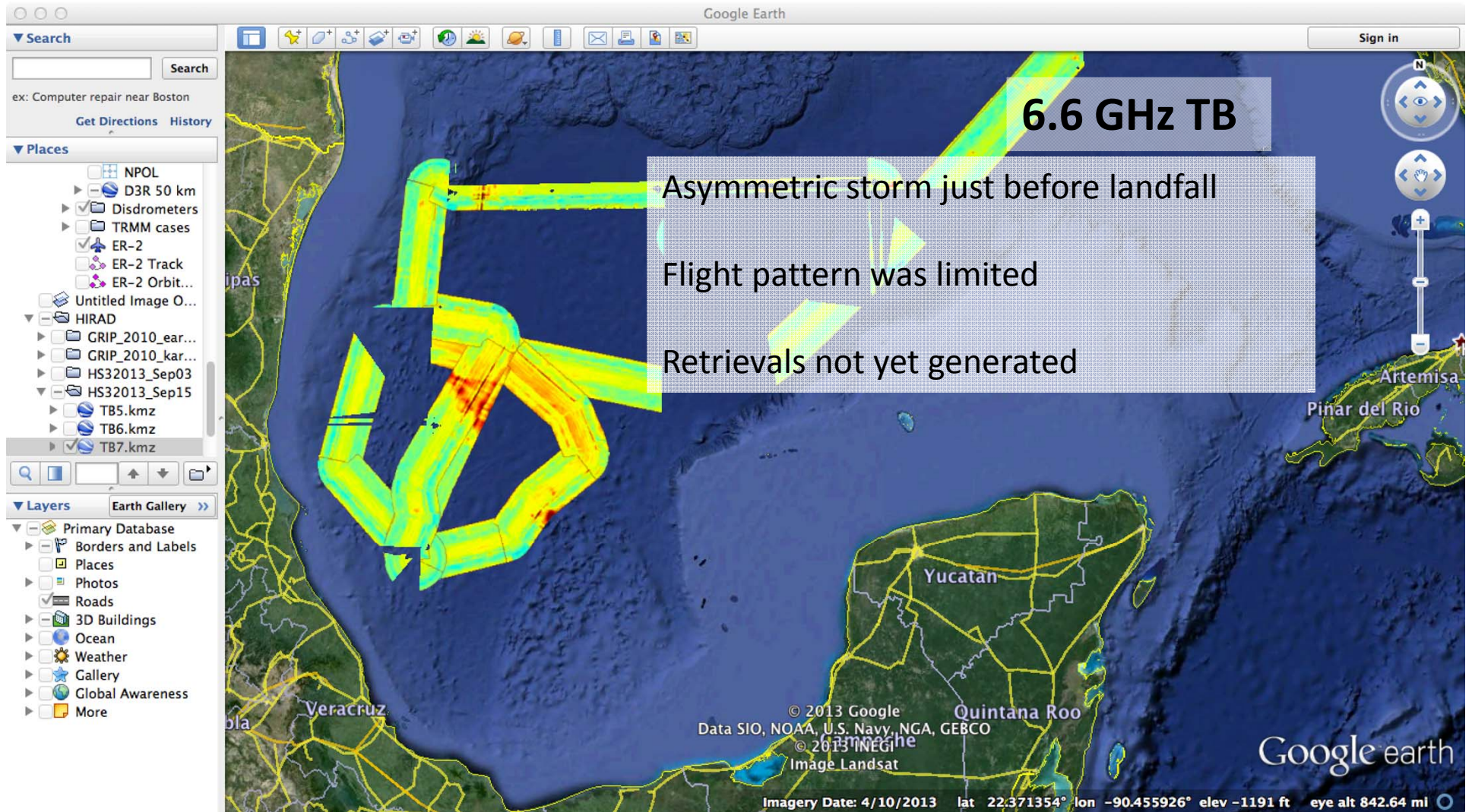


# Pre-TD Gabrielle (2013) Brightness Temp





# Hurr Ingrid (2013) Brightness Temp





# Upcoming work

- New wind and rain retrievals this spring, from recent updates to brightness temperature patterns
- Test ways to improve antenna sensitivity, reduce noise sources, improve characterization of measurements
- HS3 flights Aug-Sep 2014
- See also related papers by Mary Morris and Cereese Albers, in this conference